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DEVELOPMENT

OF

A PORTABLE DATA RECORDER

TASK II REPORT

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INTRODUCTION

This report represents the second in a series of three reports concerned with the development of a Portable Data Recorder (PDR) for the U. S. Geological Survey (USGS). The first report described the requirements of the USGS inspectors with respect to their use of the Portable Data Recorder. The purpose of this report is to present the rationale for and the design of the keyboard for the PDR. Both USGS operational requirements and acceptable human factors engineering methods were used to accomplish this task.

PDR OPERATIONAL PROCEDURES

In the Task I report, a five-step data handling system utilizing the PDR was outlined and explained. These five steps are presented here in Figure 1. In order that the PDR could be conveniently used in this scenario, its operating program has been designed so that the PDR operates in three distinct modes. For convenience, these modes will be referred to as the TERMINAL, TAPE, and DATA modes. The various operations performed in each of the modes is explained below. The keyboard commands available to the user to control these operations are explained in a later section.

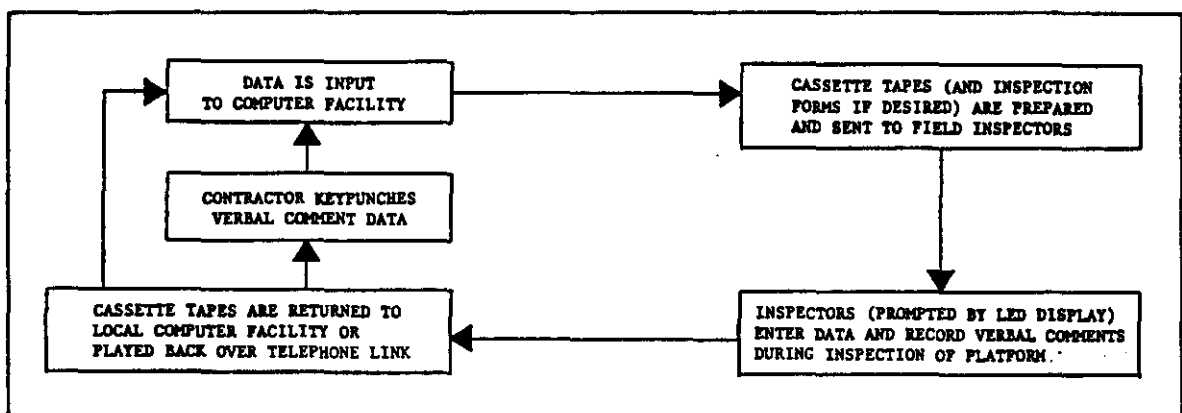


FIGURE 1. PROPOSED DATA-HANDLING SYSTEM USING PORTABLE DATA RECORDER

TERMINAL Mode

In the TERMINAL mode, the PDR emulates the function of a time-sharing data terminal. In this mode of operation, the user has four options. These include logging onto the USGS data base system, using the system to either load the PDR with a new data base or save an updated data base already in the PDR by loading it into the timeshare data base system, entering the TAPE mode, or shutting off the PDR.

TAPE Mode

While in the TAPE mode, the user may use the PDR's cassette tape drive to store the data base information (obtained from either the USGS data base system or during a field inspection) onto the cassette tape from the PDR's solid state memory. Likewise, the user can put data base information stored on the cassette tape into the solid state memory. In addition, the user can enter either the TERMINAL or DATA modes of operation, or shutoff the PDR. Finally, any verbal comments or instructions recorded on the cassette can be played back at this time.

DATA Mode

In the Data mode, the user may examine and modify various portions of the PDR's data base. When the DATA mode is entered, the PDR will immediately search for the identification information associated with the COMPLEX (group of structures to be inspected) for this data base. If no such information is found, it indicates that the required data base for the COMPLEX has not been successfully loaded into the PDR's solid state memory. In this case, an error message is displayed and the TAPE mode is reentered. Once the identification information has been found, the PDR is ready for normal operation in the DATA mode.

The data is structured in semi-hierarchical fashion. That is, various aspects of the inspection process are gathered together in groups of records according to their relationship with one another. For example, in a record group titled ATMOSPHERIC VESSELS, inspection data concerning pressure and atmospheric vessels is stored. Similarly, a record titled ENFORCEMENT is used to store all regulatory enforcement actions taken by the inspector. It can be seen that this data structure is very similar to that currently in use, except that, instead of using individual inspection forms to provide a data structure, the PDR uses groups of data records. The relationship between the various record groups is shown in Figure 2.

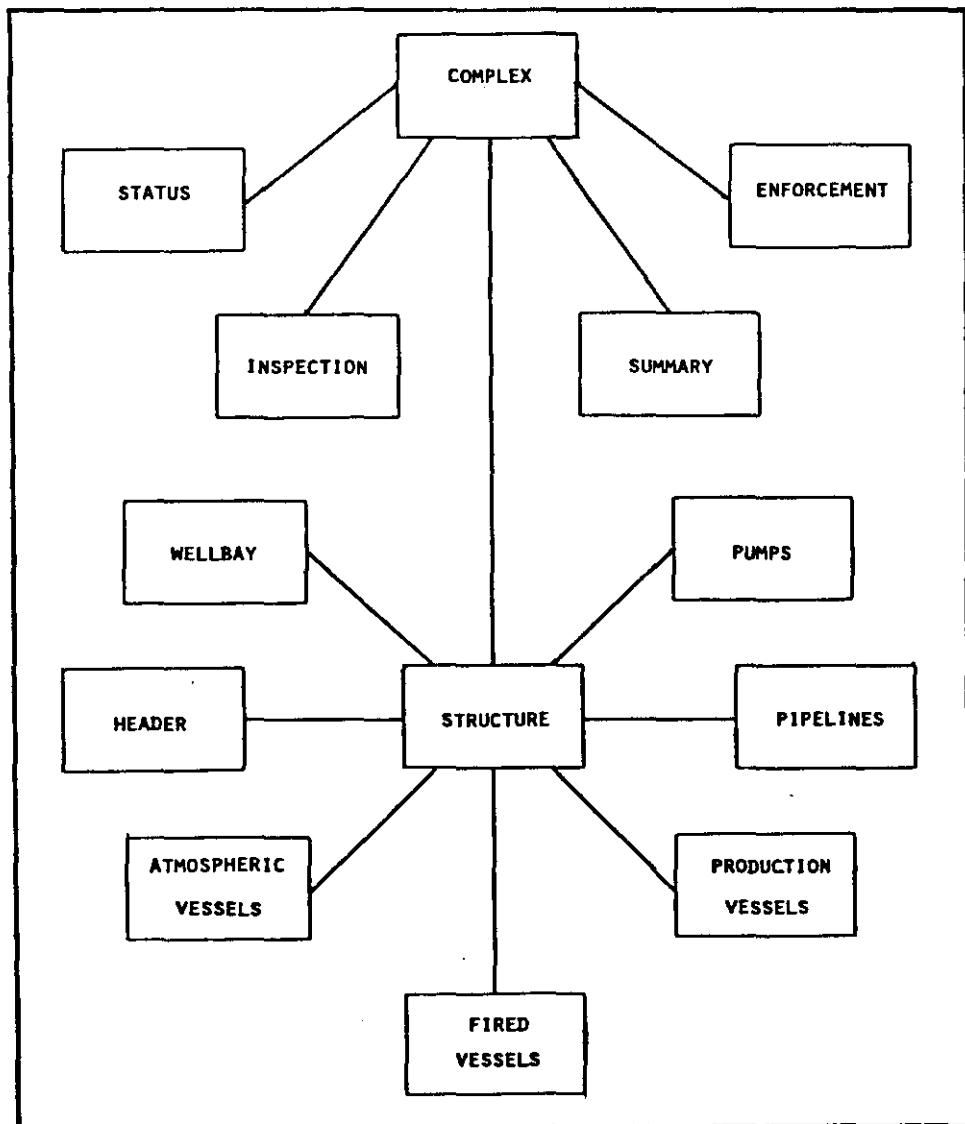


FIGURE 2. DATA STRUCTURE USED BY PDR

The user must search down the hierarchy to access the data he wishes to examine or modify. For example, when the DATA mode is initially entered, the display will be showing information about the COMPLEX.

If the user wants to know what information can be accessed at the next level of the data hierarchy, the MENU command is keyed and a table of contents is displayed. This table shows the user which data records can be accessed from his current position in the hierarchy. For example, when in the COMPLEX record, the user would see the following information upon request of the MENU:

1. STATUS
2. INSPECTION
3. STRUCTURE
4. SUMMARY
5. ENFORCEMENT

If the user wishes to enter the WELLBAY records (see Figure 2), he cannot do so directly from the COMPLEX record. It would first be necessary to enter the STRUCTURE record. To enter the STRUCTURE record, the user would key FIND 3. The PDR would find and display the data record associated with the first structure in the complex. If there were more than one structure, the user could key NEXT, and the PDR would find and display the data record for the next structure in the complex.

Note that each time the user changes records, the data for the current record, if modified by the user, will be saved in the PDR data base, and the old information for that record will be lost. If the user wishes to restore the old contents (and thus lose any current data), it must be requested explicitly before going to the next record.

In addition to examining and modifying the PDR data base while in the DATA mode, the user may also return to the TAPE mode. The following section explains the physical layout of the display and keyboard designed for use in the PDR.

PDR DISPLAY AND KEYBOARD DESIGN

The PDR's display and keyboard are comprised of a single handheld unit that is attached by an electrical signal cable to the beltpack unit containing the tape drive, microprocessor, and power supply. The handheld unit also contains the PDR's microphone and speaker. The display is located at the top of the unit and consists of two rows of 20 alphanumeric-character LED displays. The keyboard is an 5 x 8 matrix. This handheld unit is shown schematically in Figure 3.

The display operates in the following manner. A single data record can be displayed. The top row of the display will have field identification information (equivalent to the heading or titles employed on the currently used data sheets), while the bottom row will have the current data associated with the particular field. In general, current data could represent either previous data obtained from the USGS data base system or that entered by the insepctor as an update of the previous data.

One character in the top row of the display blinks as an indication of where data entry and modification will occur. Since, in general, an entire data record can not be displayed, the display acts as a window on the record, showing a 20-character-segment at any given time. By proper use of the commands described below, the user can shift that window anywhere on the record.

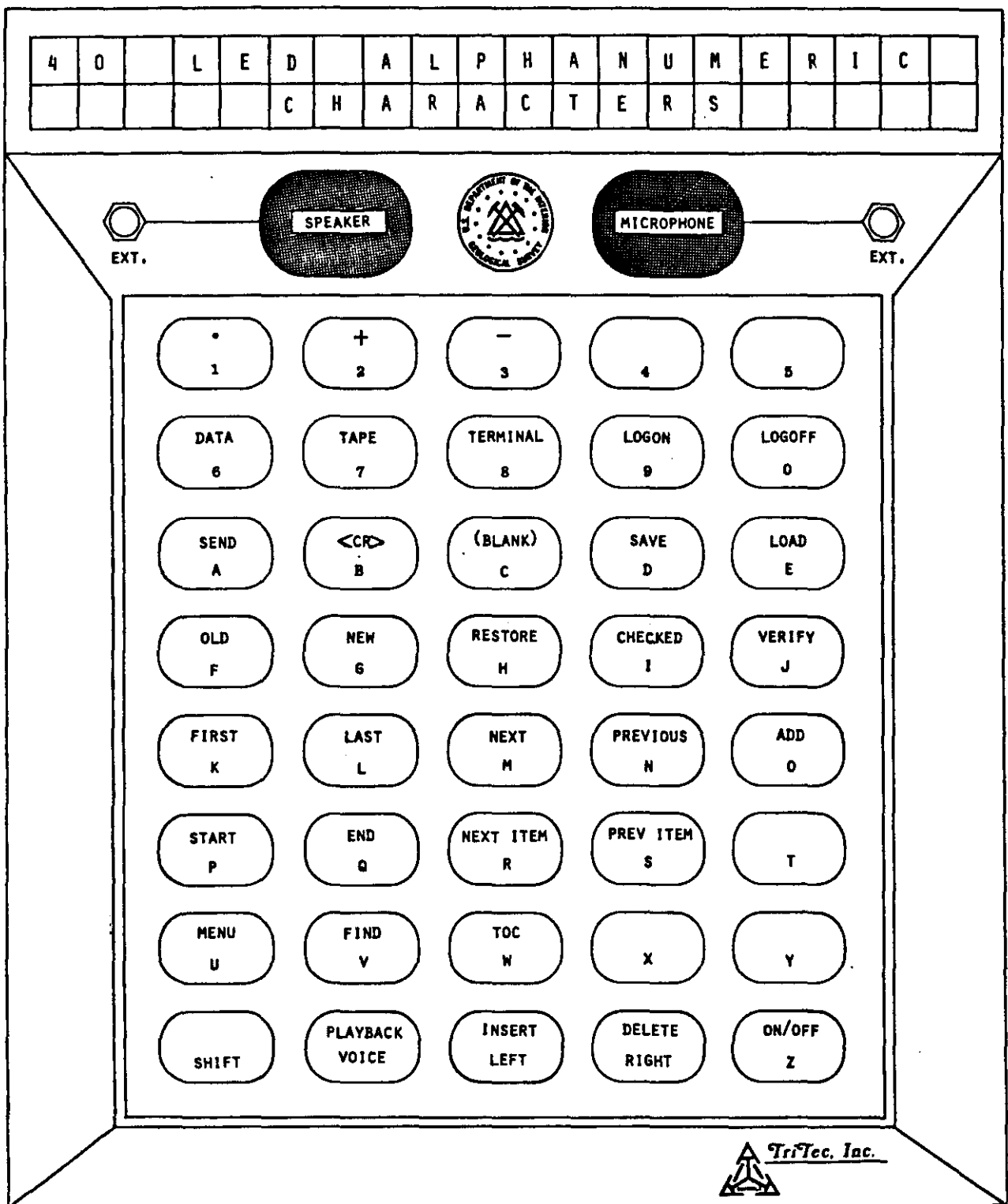
In addition to the physical arrangement of the display and keyboard, all the commands and characters from the keyboard are shown in Figure 3. The functions of each of the keys is explained below. In addition, the mode(s) in which the keys may be used is indicated by one or more numbers in parenthesis following the explanation. The numbers in parenthesis indicate the following:

1. USED IN TERMINAL MODE
2. USED IN TAPE MODE
3. USED IN DATA MODE

Upper Case Keys

These keys are available when the SHIFT key is depressed. They include:

- . These characters (decimal, plus, minus) are used
- + to define the value of numeric data field. (1,3)
- DATA This command causes the PDR to enter the DATA mode of operation. (2)



NOTE: TOP DESIGNATION ON EACH BUTTON IS USED WHEN SHIFT BUTTON IS DEPRESSED;
BOTTOM DESIGNATION IS FOR USE WITHOUT SHIFT BUTTON.

FIGURE 3. LAYOUT OF PDR DISPLAY AND KEYBOARD

TAPE	This command causes the PDR to enter the TAPE mode of operation. (1,3)
TERMINAL	This command causes the PDR to enter the TERMINAL mode of operation. (2)
LOGON	This command initiates communication between the PDR and the USGS data base system. (2)
LOGOFF	This command terminates communication between the PDR and the USGS data base system. (2)
SEND	This command causes inspection data in the PDR's solid state memory to be transmitted to the USGS data base system. (1)
<CR> (CARRIAGE RETURN)	This command is used to signify to the USGS data base system that a complete data field has been entered into the PDR keyboard. (1)
(BLANK)	This command causes the entry of a blank character or space into the data record currently being displayed. (1,3)
SAVE	This command causes inspection data in the PDR's solid state memory to be stored onto the tape cassette. (1,2)
LOAD	This command causes inspection data stored on the cassette to be loaded into the PDR's solid state memory. (1,2)
OLD	For the data record currently being displayed this command causes the data last stored in the PDR's solid state memory to be displayed in lieu of the data currently in the display. (3)
NEW	This command causes the contents of the NEW data buffer to be displayed. It has no effect unless the OLD command was keyed for that data record after data modifications had been made. (3)
RESTORE	This command is used if, prior to requesting the display of a new data record, it is desired that the data for the current data record last saved in the PDR's solid state memory be retained instead of being replaced by the NEW or modified data for that record. (3)

CHECKED	This command allows the user to change the status of a data field in a data record from OLD to NEW without changing its value. It is analogous to the use of a check mark on the data sheets currently in use. (3)
VERIFY	This command allows the user to verify that any or all of the data fields in the record currently displayed have been updated during the inspection process. (3)
FIRST	This command causes the first record in a data record group to be displayed in place of the record currently displayed. Unless the RESTORE command is keyed prior to FIRST, the currently displayed data will replace the old data in the PDR's solid state memory. (3)
LAST	This command is the same as the FIRST command, except that the last data record in the current record group is displayed instead of the first. (3)
NEXT	This command is the same as the FIRST command except that the next data record in the current record group is displayed instead of the first. (3)
PREVIOUS	This command is the same as the FIRST command except that the previous data record in the current data record group is displayed instead of the first. (3)
ADD	This command allows the user to add a data record to the current data record group. (3)
START	This command causes the display to move to the beginning of the currently displayed data record. (3)
END	This command causes the display to move to the end of the currently displayed data record. (3)
NEXT ITEM	This command causes the next item or data field in the currently displayed data record to be shifted to that part of the display where it can be modified by data entered via the keyboard. (3)

PREV ITEM This command is the same as the NEXT ITEM command, except that the previous item (i.e., data field) is shifted. (3)

MENU This command causes the display of a record containing the titles of all of the data record groups that the user can access from the current position in the data structure. The various record group titles are numbered in the MENU. This command is used in conjunction with the FIND command. (3)

FIND This command is used in conjunction with the MENU command to access a record type other than that currently being displayed. The user, viewing the display of numbered record groups provided by keying MENU, keys FIND i, where i is the number corresponding to the record group he wishes to access. This causes the first record of the ith record group to be displayed. As with the FIRST command, the currently displayed data field displaces the equivalent data record previously stored in the PDR's solid state memory unless the RESTORE command was keyed. (3)

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(TOP OF COMPLEX) This command is the same as the FIRST command except that the first record of COMPLEX is displayed instead of the first record of the current record group. (3)

PLAYBACK This command causes any voice entry on the tape cassette to be played back over the PDR's speaker. (2)

INSERT This command causes the characters to the right of the data entry point in the data field currently located at the data entry point to shift one space to the right, leaving a blank at the data entry point. The last character of the same data field is deleted in order to maintain a constant data field length. (1,3)

DELETE This command causes the characters to the right of the data entry point in the data field currently located at the data entry point to shift one space to the left, deleting the character at the data entry point. The blank character is added to the end of the same data field in order to maintain a constant data field length. (1,3)

ON/OFF This command causes the machine to go from an off to on status, and from on to off status. (1,3)

Lower Case Keys

- 1,2,..9,0 These numbers are used to enter numeric data into the PDR. (1,3)
- A,B..,Z These letters are used to enter alphabetic data into the PDR. (1,3)
- SHIFT This command, when used simultaneously with another key, causes the upper case command associated with that key to be executed. (1,2,3)
- VOICE While depressed this command activates the audio tape recorder and allows verbal comment data to be entered by the user onto the tape. (3)
- LEFT This command causes the display to increment to the left. (3)
- RIGHT This command causes the display to increment to the right. (3)

SUMMARY

The foregoing description of the design and operation of the PDR represents the best information available, since at the time of this report neither the hardware nor software designs have been finalized or implemented. Therefore, this report is intended as an overall guide to the philosophy behind the design and not as a detailed description of the exact implementation that the final design will embody.